

# Climate Change and Black Carbon in the Himalayas

Among the world's mountain regions, the Himalayas play a particularly important role. About 1.5 billion people live in downstream river basins of the Himalayas. Melting snow and glaciers could severely impact ecosystems and human well-being in the region.

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Atmospheric Brown Cloud over the Ganges Plain (NASA/MODIS)

Over the past century, air temperatures increased in the Himalayan-Tibetan region at a pace similar to the global average. Since 1979, however, a very rapid temperature increase has been identified in the middle troposphere during the pre-monsoon season. This temperature increase spans a region stretching from the Himalayas across Pakistan, Afghanistan and Iran, all the way to the Arabian Peninsula, with appreciable warming occurring over the Hindu Kush mountains [1, 2]. This strong increase has been partly attributed to the presence of black carbon or dust in the middle troposphere. These aerosols absorb solar radiation and heat the surrounding air. The cloud of aerosols that forms over the Indus Valley and northern Indian Ocean each year is called the "Asian Brown Cloud" – it is mainly caused by human-induced pollution from domestic or agricultural wood burning, industry, traffic, etc. It severely affects human health in the Indo-Gangetic Plain. In addition to increasing mid-tropospheric temperatures through absorption and decreasing surface temperatures by dimming the sun, aerosols affect the generation and dynamics of clouds and have been posited to affect atmospheric circulation. They may influence hurricanes over the Indian Ocean or play a role in the onset of monsoons; however, the nature of these impacts is not yet fully understood.





Air pollution over Kathmandu, Nepal (T. Kohler)

Aerosol deposition lowers the albedo of glaciers in the central Tibetan Plateau, with less solar radiation reflected back into the atmosphere. Thus, aerosols could be contributing to glacier melting. However, insufficient observation and the lack of a monitoring network in this critical region have hampered our understanding of the dynamics at play.

No long-term trend has been found in seasonal mean monsoon rainfall. In the future, the Asian monsoon circulation is expected to weaken and its moisture content is expected to increase. As a result, more intense monsoon rainfall events are predicted.